

APPENDIX V – Ozonesonde Instruments

Ozonesondes were introduced into atmospheric science in the 1960s [Komhyr, 1964, 1967, 1969] and have had a long development history. These “in situ” instruments using balloon platforms are particularly appropriate, and in fact unique in providing ozone profiles in the troposphere and lower stratosphere, with maximum altitudes at balloon burst, usually near 30 km. Many intercomparisons between different ozonesonde types and reference instruments have been conducted over the last 40 years [Attmannspacher and Dütsch, 1970; 1981; Barnes et al., 1985; Hilsenrath et al. 1986; Kerr et al., 1994; Beekmann et al., 1994; 1995; Komhyr et al., 1995a; 1995b; Reid et al., 1996; Boyd et al., 1998; Johnson et al., 2002; Fioletov et al. 2006; Terao and Logan, 2007; Smit et al., 2007; Deshler et al., 2008; Stübi et al. 2008]. Therefore, this is a proven technique which doesn't require further justification to be accepted as an NDACC instrument.

The peculiarity of ozonesondes is that every instrument is usually new and flown only once. Therefore, the notion of a reference/standard instrument has to be interpreted differently than for other types of instruments. In the case of ozonesondes, the main emphasis is on the standard operating procedures (SOPs) for preparation of the instruments for flight, and on the data processing.

From recent laboratory [Smit et al., 2007] and field [Deshler et al., 2008] experiments, it can be concluded that different ozonesondes provide very reproducible and consistent results. If the SOPs are strictly followed, the variability (precision) between sondes is estimated to be ± 0.1 mPa in the troposphere and ± 0.2 mPa ($\pm 2\%$) in the stratosphere.

Quality Criteria for the Evaluation of New Ozone Sounding Station

Long term monitoring networks of ozone sounding stations as well as project dedicated networks have developed optimal practices over the years. Within these networks three different types of ozonesondes are still employed: electrochemical concentration cell (ECC), Brewer Mast (BM), and the Japanese KC sonde.

ECC ozonesondes are now the most widely used ozonesonde type. Two companies produce ECC sondes, Science Pump Corporation (SPC) and ENSCI Corporation. The two manufacturers recommend their own procedures, which differ slightly. These along with expertise gained in the operational ozonesonde networks, such as NDACC, and comparisons organized by the World Meteorological Organization (WMO) have been used to improve these recommendations. These improvements have evolved to a stage where the publication of SOPs for ECC ozonesondes will be made available soon by the WMO.

Presently only one station (Hohenpeissenberg) is still using BM ozonesondes operationally. Since 1976, a document defining the SOPs for the Brewer-Mast ozonesonde has been available. It defines the different steps to complete proper and reproducible ozone profiles with BM sondes.

The third still active instrument is the Japanese sonde KC92 [Kobayashi et al., 1966; Fujimoto et al., 2004]; however this instrument is being replaced by ECC sondes by the Japanese Meteorological Agency. No other stations have used KC sondes.

Under the WMO umbrella, there is also a network of global ozone sounding stations which partially overlaps the NDACC network. The WMO has attributed the role of the world calibration center for ozonesondes (WCCOS) to the Research Center in Jülich. The primary goals of the WCCOS are to promote understanding of the instrument, to establish well documented SOPs, and to assess differences in instrument manufacturers and in variations of SOPs in use. The WCCOS along with NDACC investigators were instrumental in establishing the guidelines behind the presently recommended SOPs which should be available on the WMO web site soon. At that time this document will be cross linked from the NDACC ozonesonde web site. WCCOS continues to periodically test the quality of ECC ozonesondes provided by the two manufacturers. The role of the WCCOS is endorsed by the NDACC ozonesonde working group and there is a good collaboration between NDACC and WCCOS.

The manufacturers of ozonesondes produce a consistent product with well established characteristics. Therefore, the evaluation of candidate ozonesonde stations to be accepted into the NDACC network will be primarily based on their compliance with recommended standards for instrument operation and data analysis. Such recommendations are either available in the SOPs for BM sondes or the soon to be released SOPs for ECC sondes. These guidelines are not meant to discourage the important scientific contributions to our understanding of ozonesonde characteristics which can be made through-experimental work; however, in such cases where a station wishes to deviate from the SOPs for either practical or scientific reasons the NDACC will support such deviations provided the station PI(s) document such changes to the WG representatives and in the data base, and provide results showing the consequences of the change compared to standard ECC ozonesonde operation as defined in the SOPs.

Data File format for the ozonesonde NDACC Archive

Among other things ozonesonde data format was discussed extensively at the Ozonesonde WG meeting in February 2009 in Jülich, Germany. A working group was formed at that time to complete the work done there and to provide a document to describe the format and provide example files. The format is based on the NASA/AMES 2160 format and efforts are taken to standardize this format amongst all stations to avoid the need for a multiplicity of readers to access NDACC ozonesonde data. The relevant documents are posted on the ozonesonde working group web site. NDACC investigators will be encouraged to submit all new data with the revised format, and, although not required, to consider resubmitting all their previous data in the new format.

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